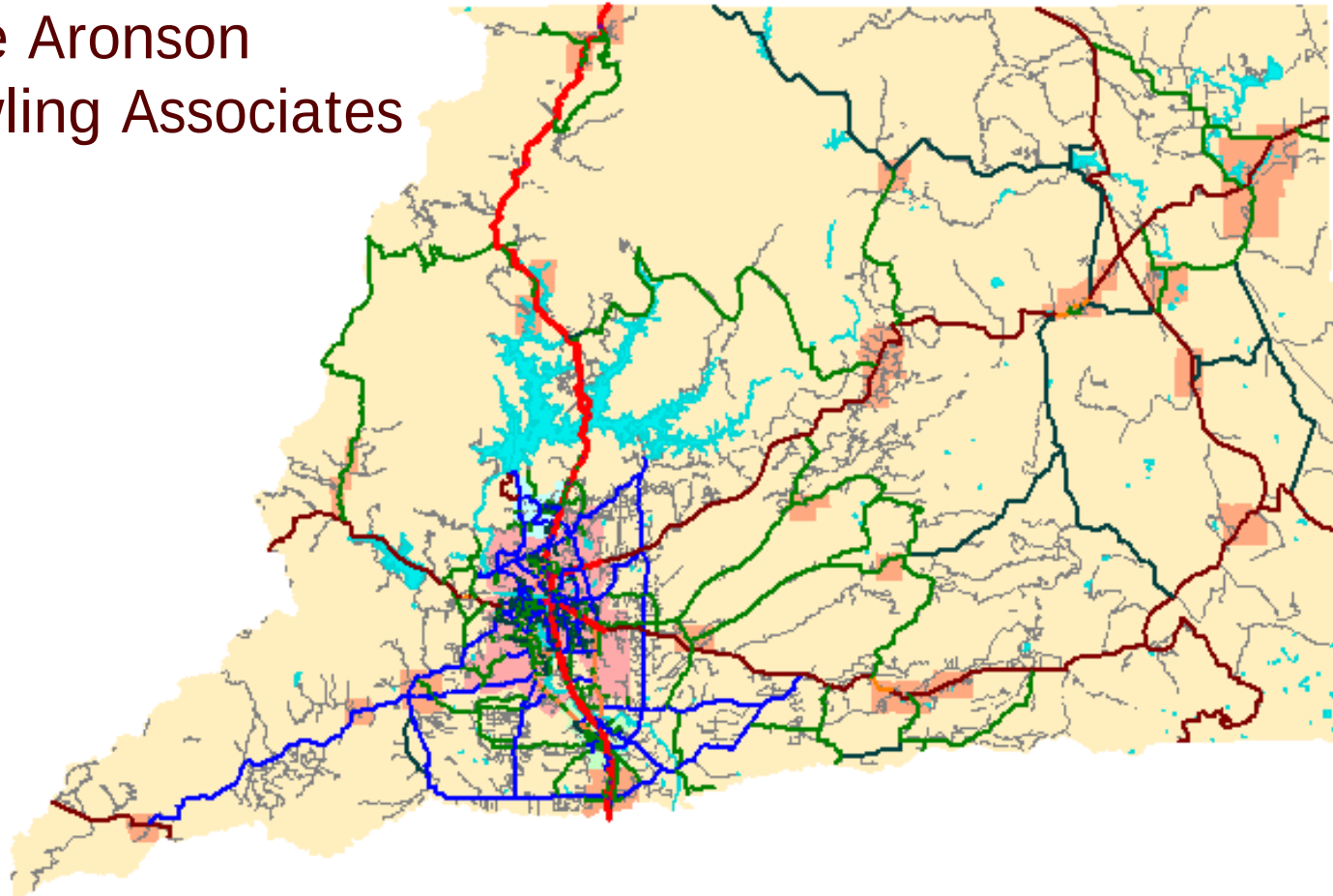


Travel Modeling in Shasta County

Mike Aronson
Dowling Associates



Travel Modeling 101

- What is a travel demand forecasting model?
- When are models useful?
- Model components
- Steps in process



What is a Travel Demand Model?

- A systematic process for translating land use and transportation supply into projections of future travel demand
- Computers and software are NOT models
- Models ***use*** computers and software to manipulate large amounts of data
- Specific land use assumptions also do not equal “the model”



Types of Travel Models

- Growth Factor
 - Example: 2.5% annual growth on a road
- Impact “Model” (Bookkeeper?) - Traffic
 - Add increments to observed counts
 - Manual assumptions for traffic amounts, directions, routes
- Travel Demand Model
 - Formulas that relate travel demand to people’s activities



Travel Demand Forecast Models

- “Travel” vs. “Traffic”
 - Can consider other modes such as transit
- “Demand”
 - The model is estimating how many people *want* to make the trips, not necessarily how many *can* make the trips when they want to
- “Forecast”
 - **OPINION:** Reasonable predictions more important than accurate replication of existing conditions



Why Bother with Travel Models?

- Can evaluate changes in travel by people who are already on the road
 - Diversion to new road connection or transit service
 - Diversions due to increased congestion
 - New land use that will divert existing travel
 - WalMart diverts from existing stores
- Evaluate several new developments that will interact with each other
 - New housing plus new jobs
- Agencies use as database for consistency



Limitations of Travel Models

- Need to group people and land uses
- Cannot predict changes in land use
- Cannot predict changes in attitudes
- With congestion, models predict demand, not throughput volumes
- Cannot directly predict intersection turns
- Only as good as inputs



Model Components

- Inputs that vary by scenario
- Inputs that are “fixed”
- Outputs
- Process
 - Equations
- Software to execute process



Model Inputs that Vary

- Road and Transit Networks
- Land Use & Socioeconomic
- Internal & External Trip Assumptions
- **SOMETIMES** Transportation Analysis Zones (TAZs)



Fixed Model Inputs

- Trip Generation Rates
- Distribution Factors (Friction Factors)
- Adjustment (“K”) Factors
- Volume/Delay Equations
- Mode Choice Parameters
- **OFTEN** Peak Hour / Peak Period Factors



Model Outputs

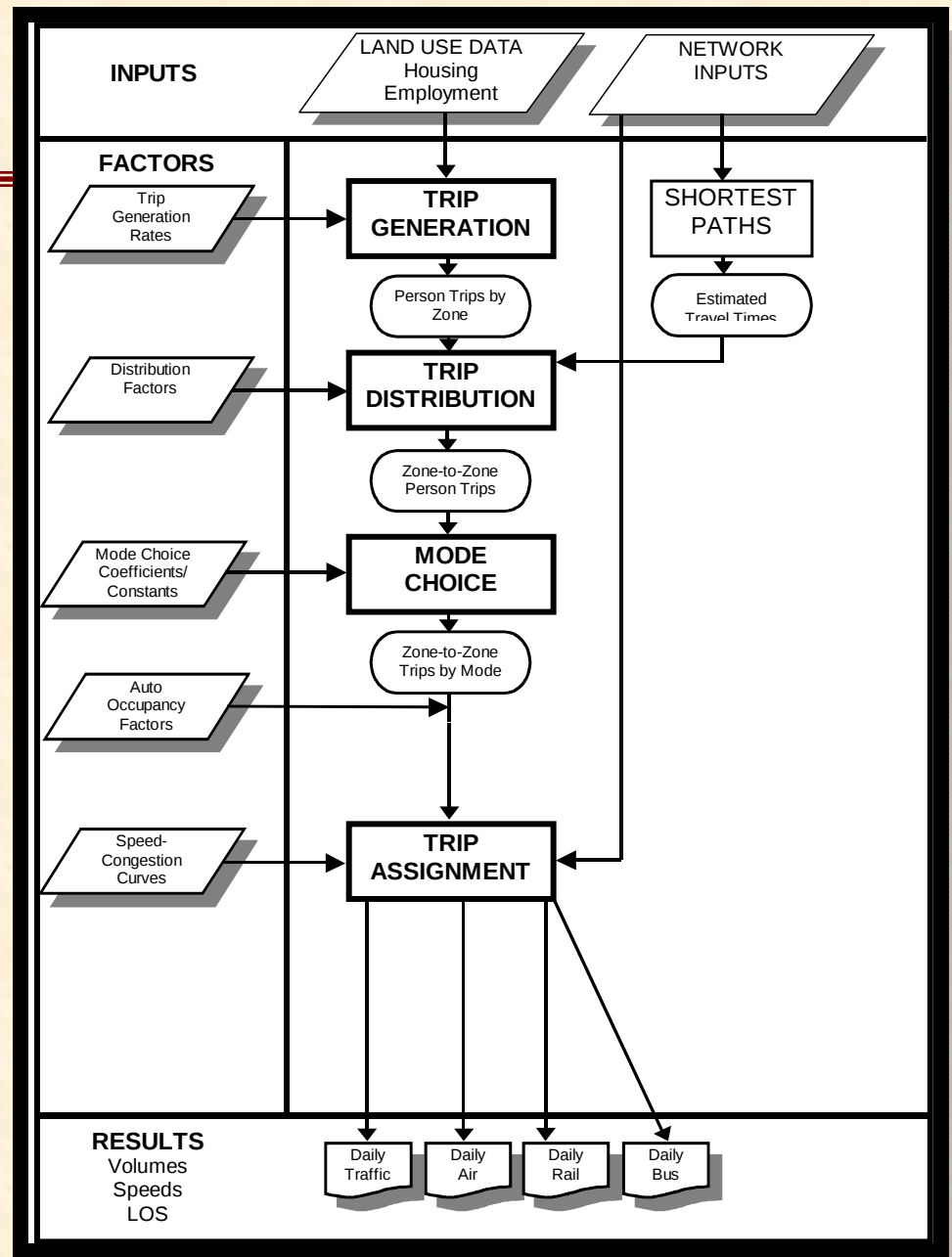
- “Loaded” network(s)
 - Copy of input networks plus volumes
- Trip matrices
- “Skim” matrices (time, distance)
- Printed reports
- Select intersection, link, zone volumes



Model Process



The Black Box



Traditional Four Step Process

- **Trip Generation**
 - How many trips travel to and from each land use?
- **Trip Distribution**
 - How many trips travel from each area to each other area?
- **Mode Choice**
 - What travel modes do they use?
- **Trip Assignment**
 - What routes do the drivers and transit riders use?



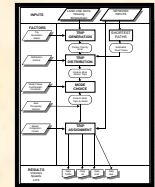
Activity or Tour-Based Model

- Population Synthesizer
 - Simulate each person in model area
- Activity Estimates
 - What activities do each person need to do on a given day?
- Random Simulation of Choices
 - Destinations, mode, time of day
- Trip Assignment
 - What routes do the drivers and transit riders use?
 - Aggregate person tours to TAZs



The Real Process

- Define Model Area – What happens at gateways?
- Code Transportation Networks
- Define Zone System – Aggregate land uses
- **Inventory Land Uses** 
- Calibration – Formulas based on survey data
- Validation – Compare model results to counts
- Forecast Inputs – Land uses, networks
- Policy Framework – Which assumptions should remain constant? 
- Adjust Model Results

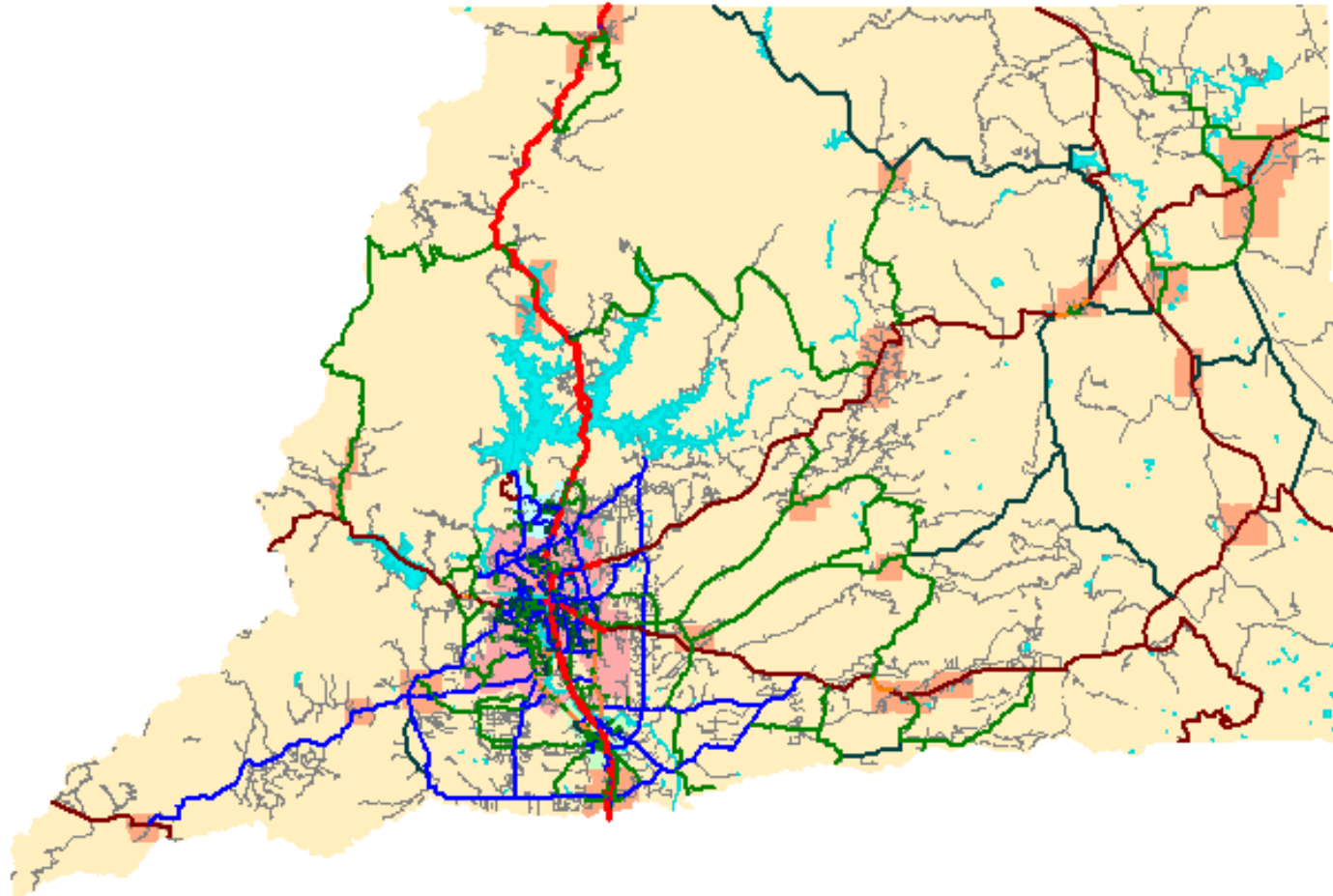


Don't Say "We're using THE MODEL"

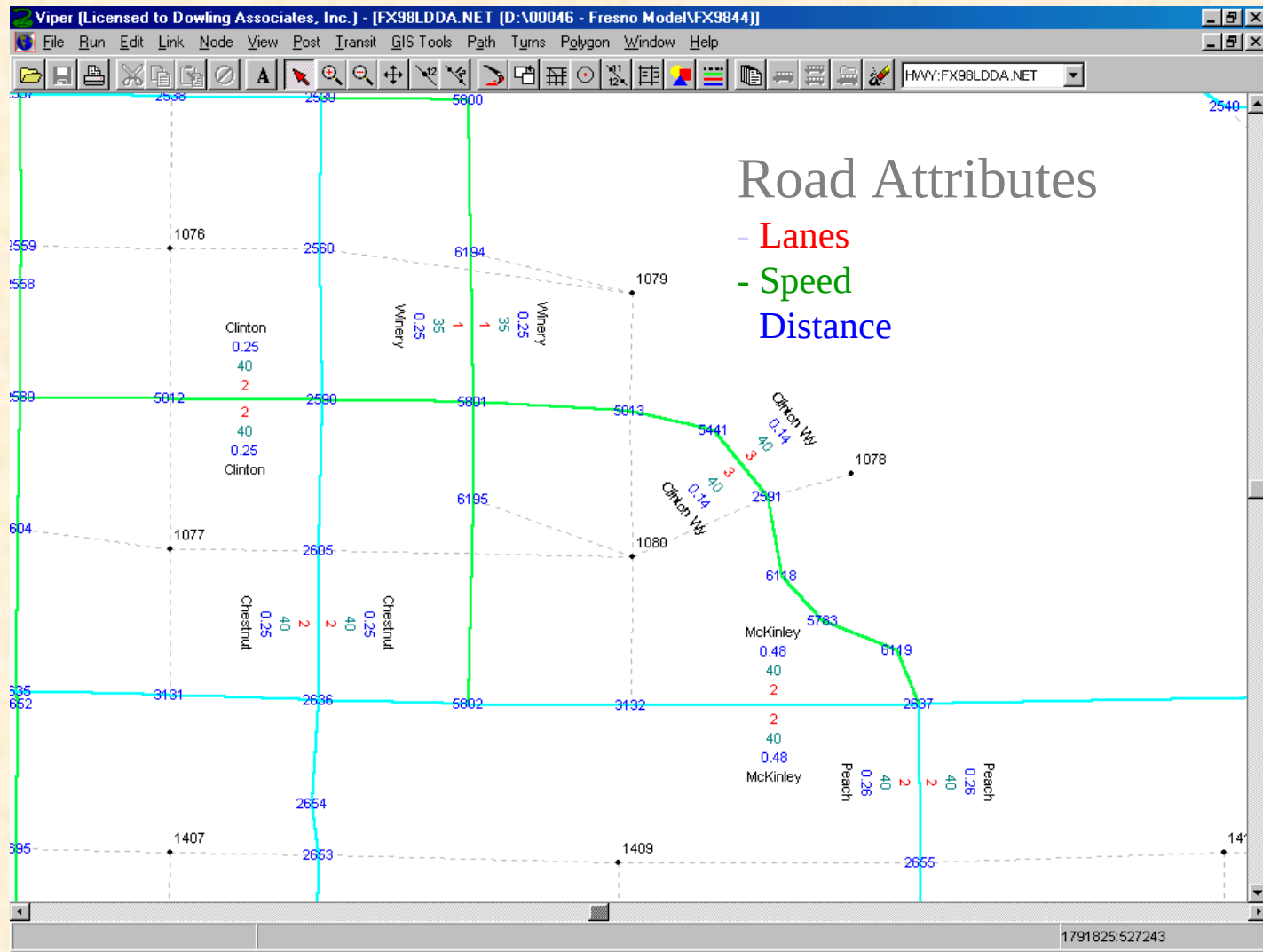
- Which version/generation of the model?
 - Example: May, 2009 update of the Vineyards version of the Shasta County 0802T model, 2025 forecast
- Which version of the software?
 - Can give different results
- The LAND USE is not THE MODEL
 - Pick best modeling tool, then update inputs
 - Example: Add Oasis Specific Plan buildout to official RTPA 2030 growth forecast
- How should results be reported?
 - Did other consultants use adjustments?



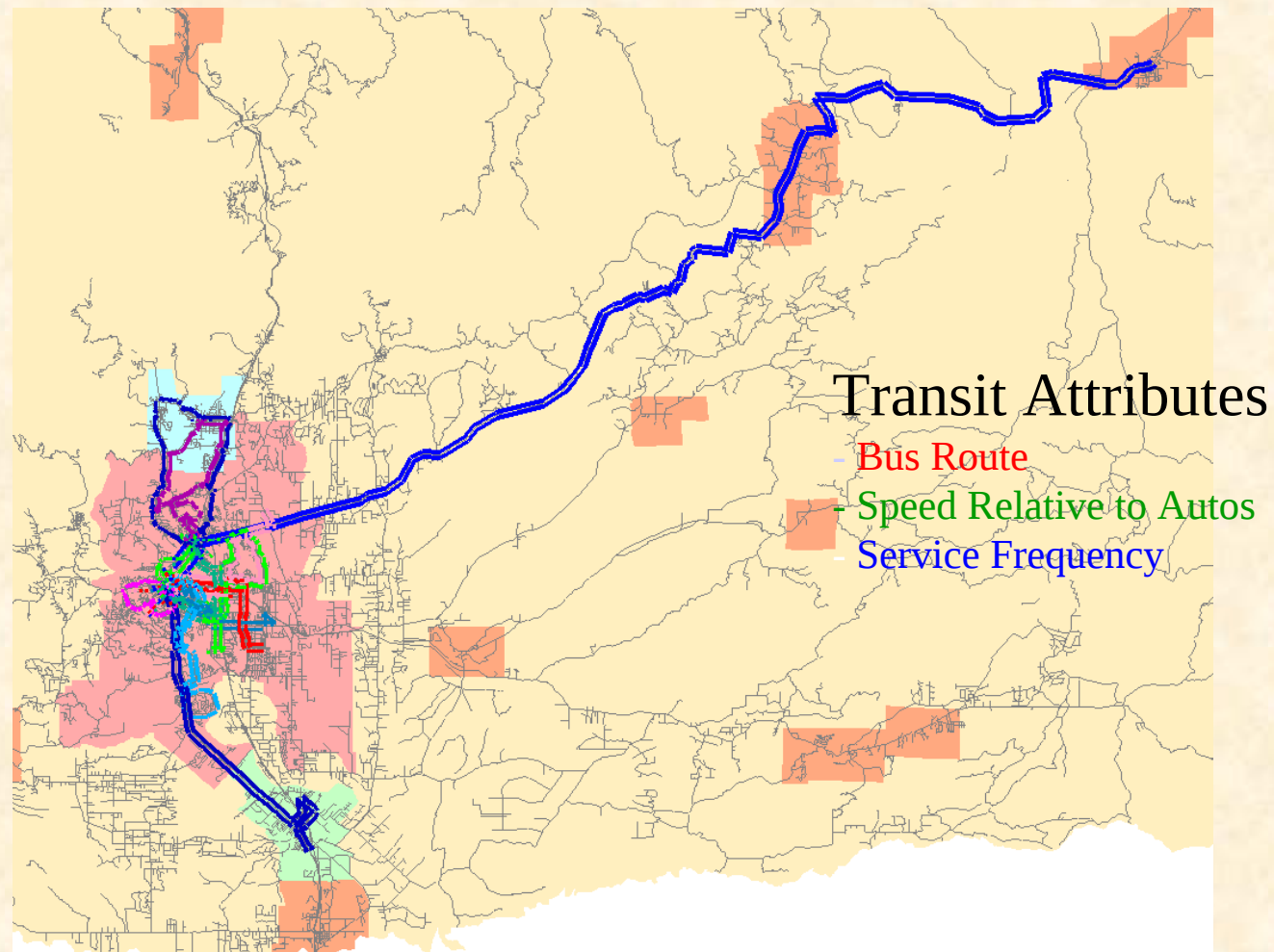
Model Inputs



Road Network Inputs



Transit Network Inputs

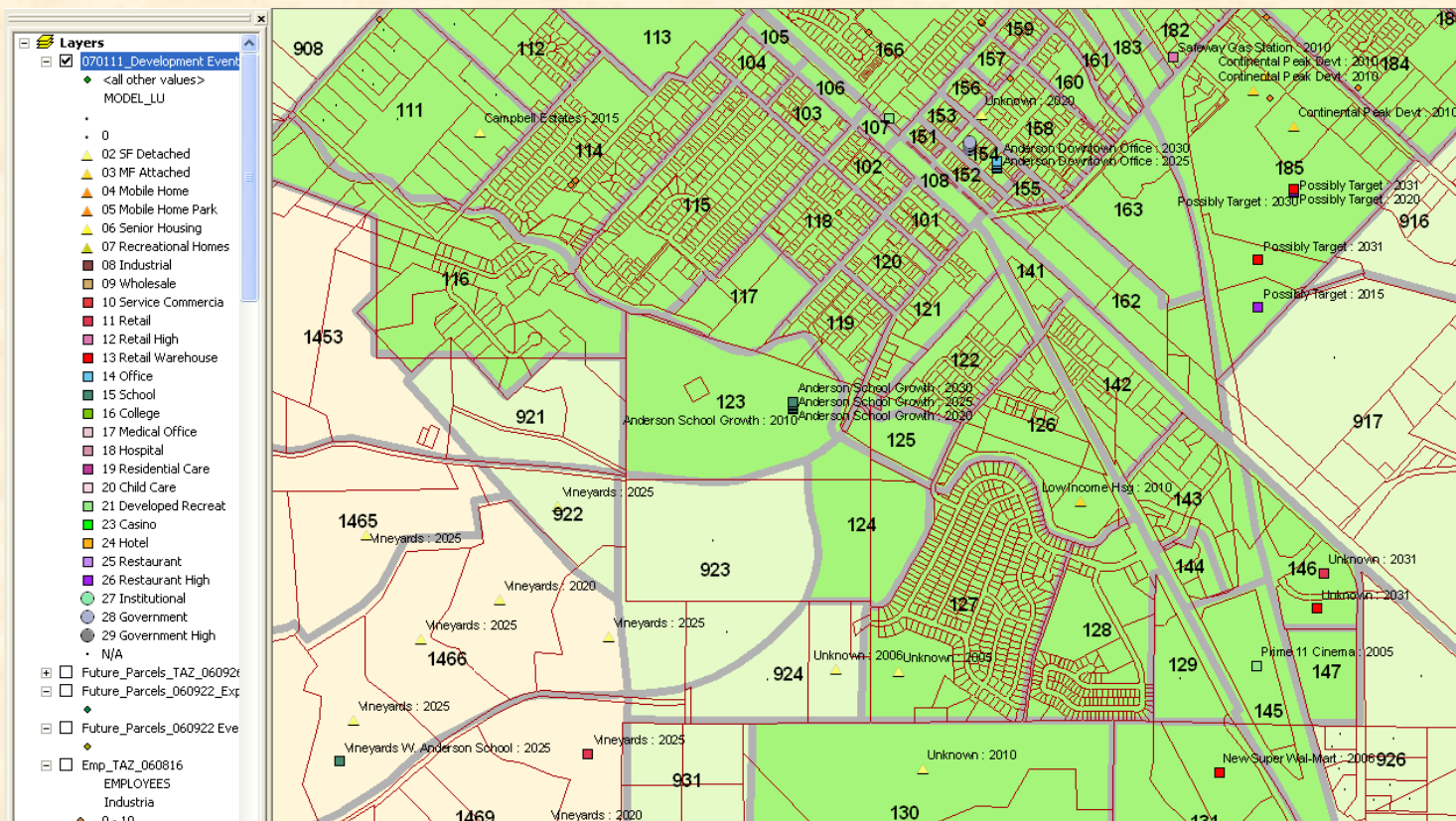


Land Use Inputs

- **Housing**
 - 6 categories including recreational housing
- **Employment**
 - 22 categories including casino
- **Socioeconomic**
 - Median income by TAZ
 - Percent 0, 1 or 2+ auto households by TAZ



Future Development Using GIS

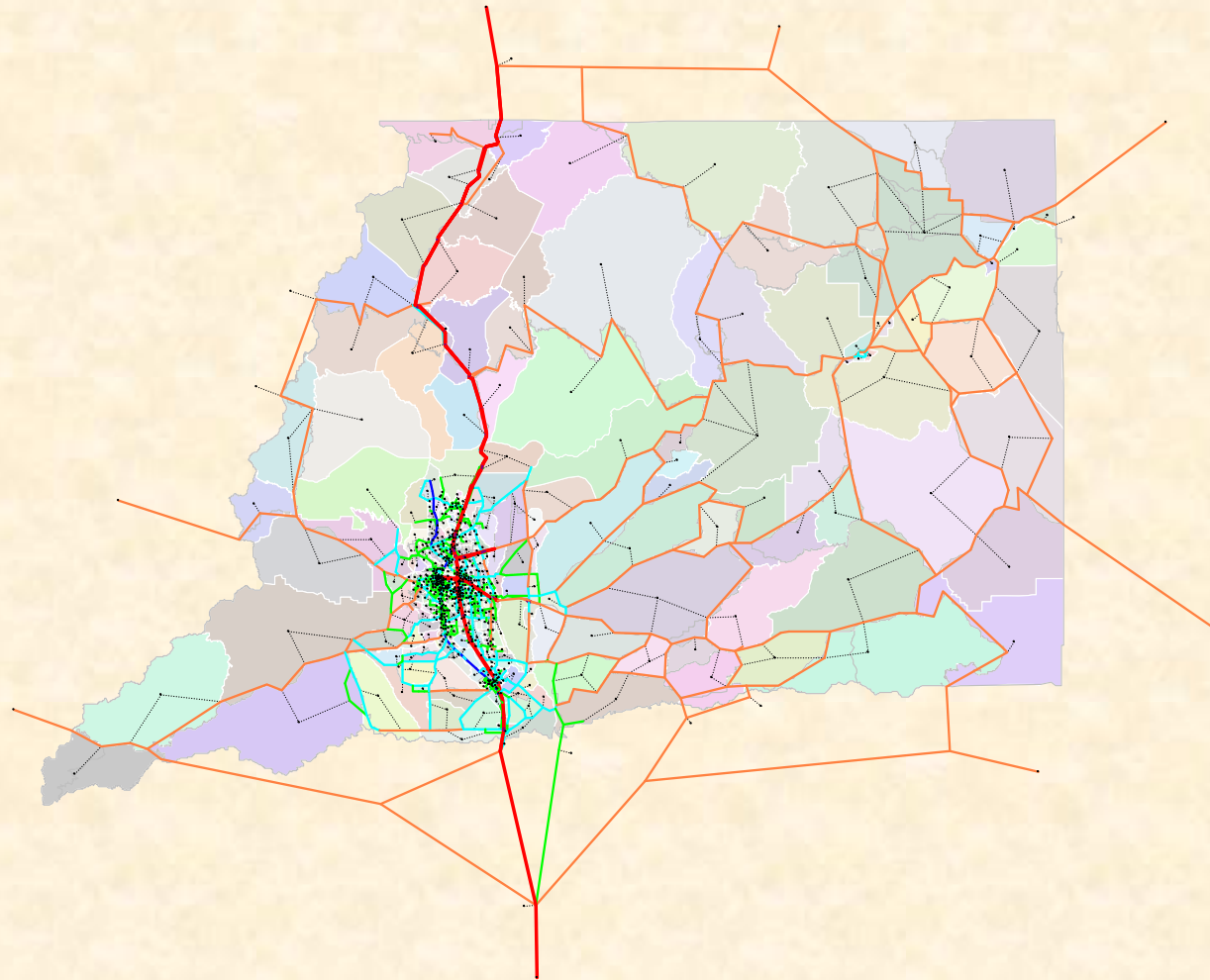


Transportation Analysis Zones

- Or:
 - “Traffic Analysis Zones”
 - “TAZs”
 - “Zones”
- Grouping of land uses into TAZs can be biggest source of model error
- High number of TAZs increases model processing times
- Activity-based models still use TAZs for trip assignment

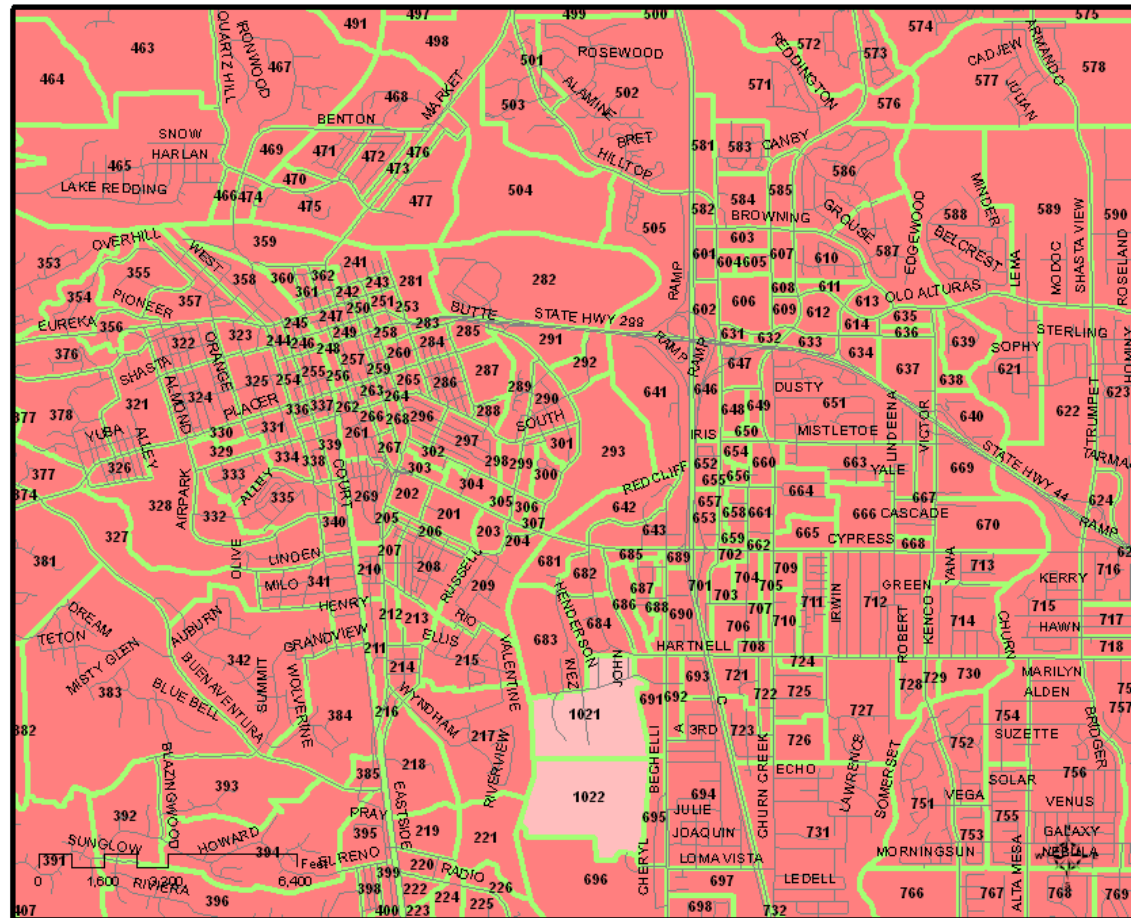


Shasta County TAZs



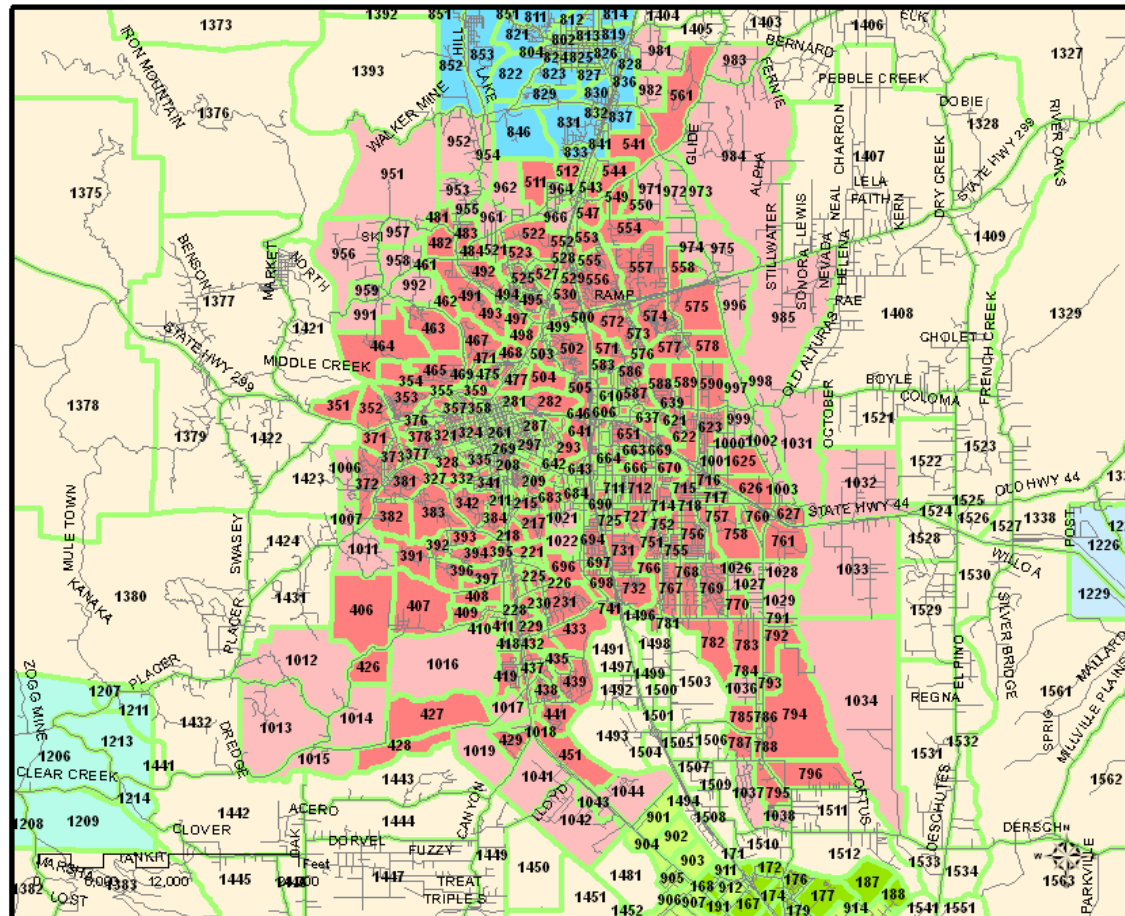
Central Redding TAZs

Shasta County Model TAZ Updates



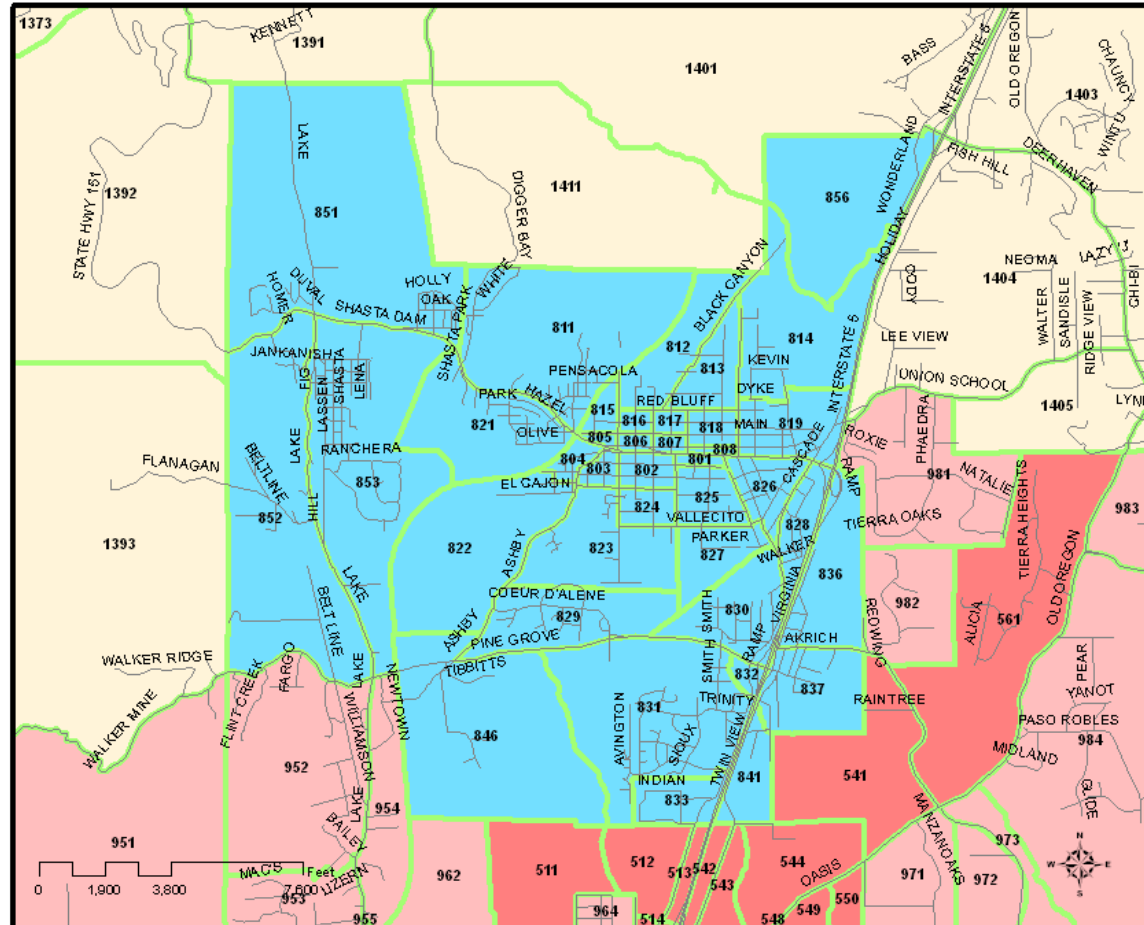
Redding TAZs

Shasta County Model TAZ Updates



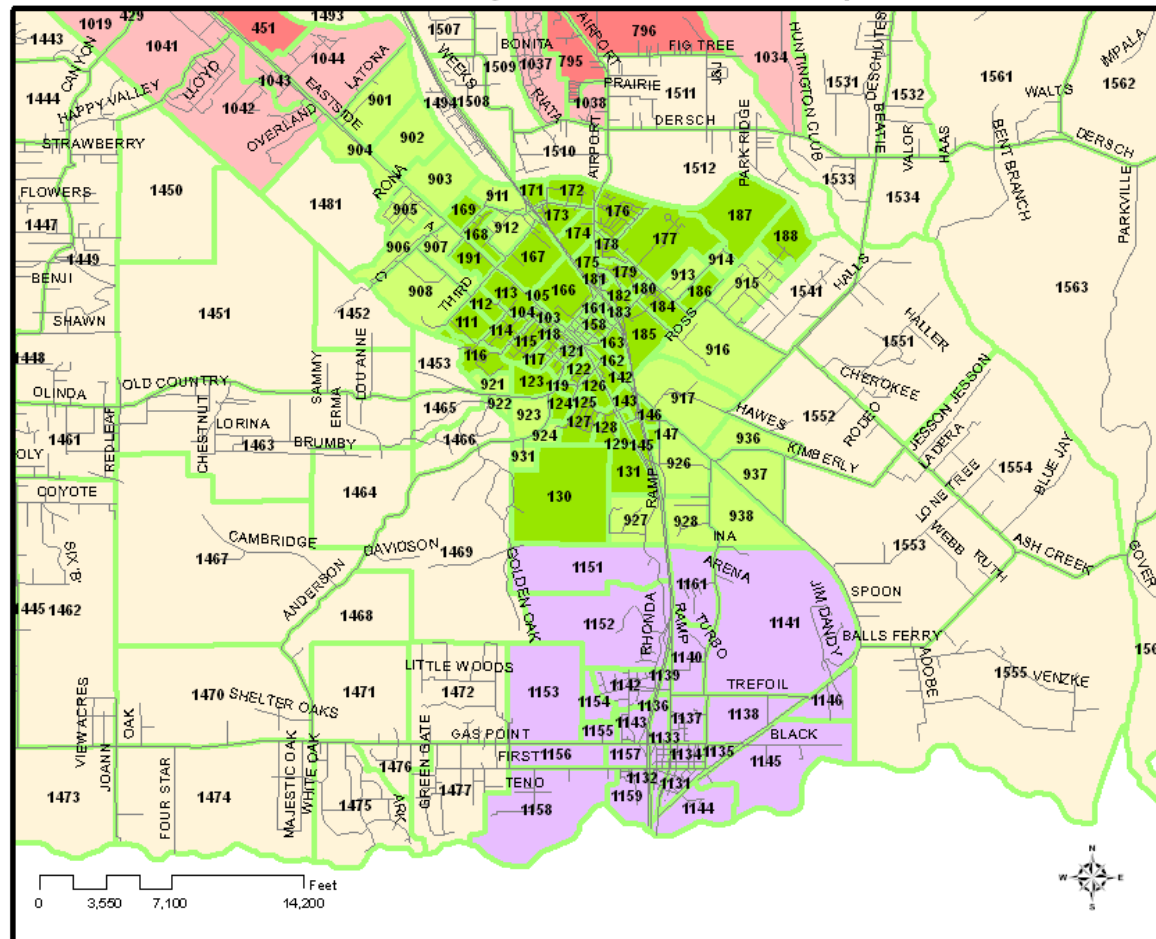
Shasta Lake TAZs

Shasta County Model TAZ Updates



Anderson / South County TAZs

Shasta County Model TAZ Updates

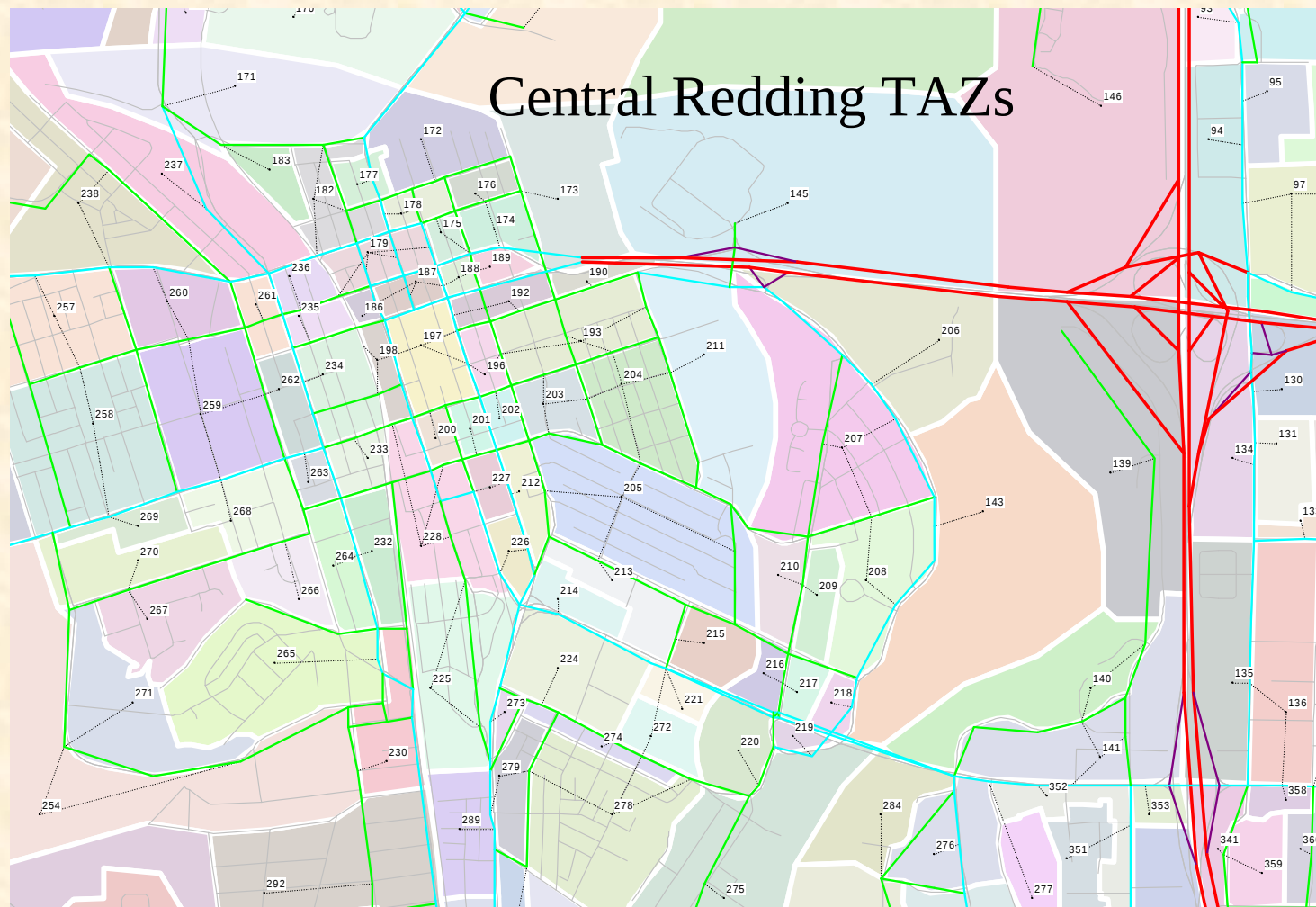


TAZ Features

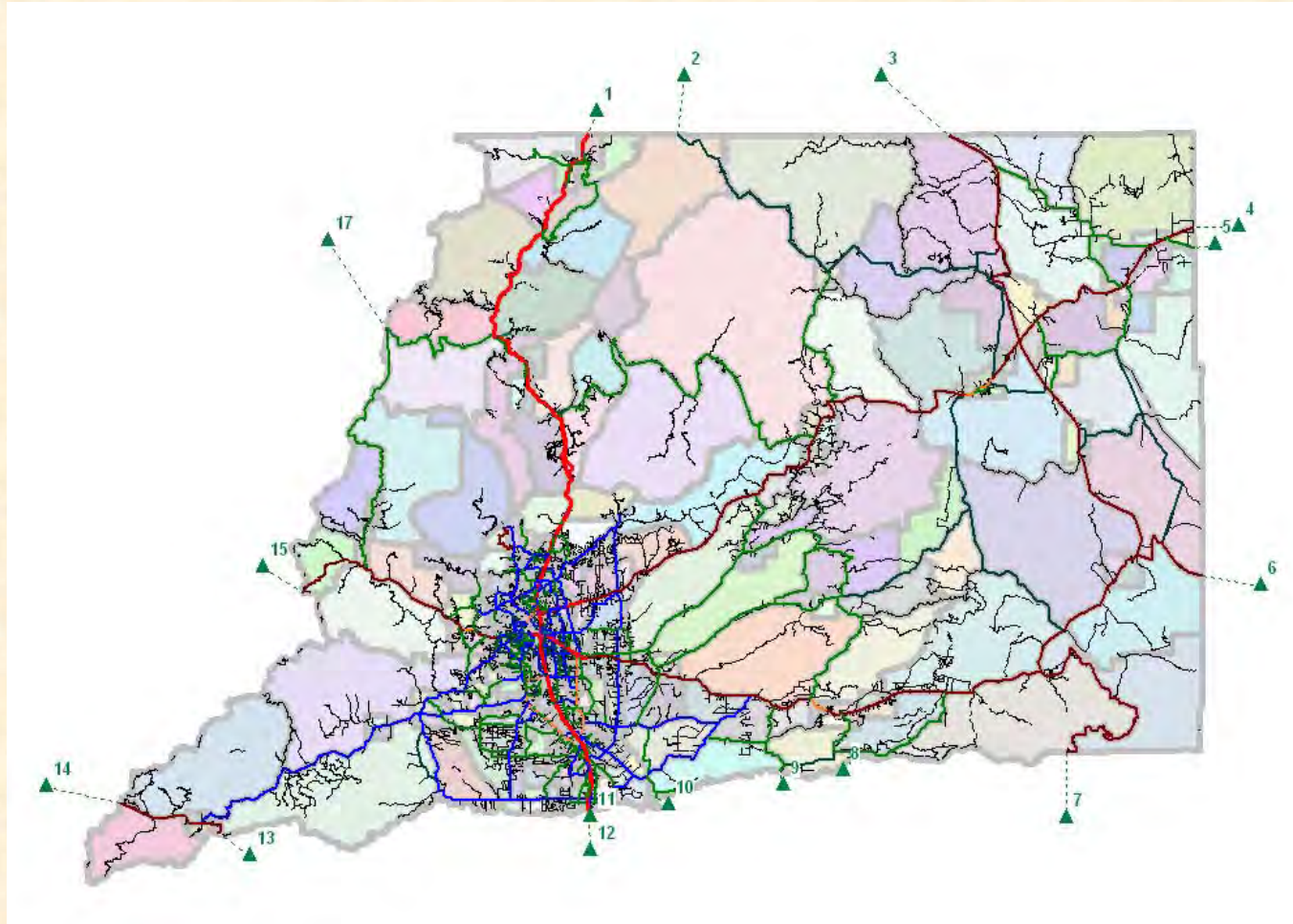
- Group land uses that have same access to transportation network
- Need to be smaller for transit modeling to isolate areas with walk access
- “Centroid” represents center of trip activity, not geographic center
- “Centroid connectors” represent access for *majority* of trips, not *all* trips in TAZ



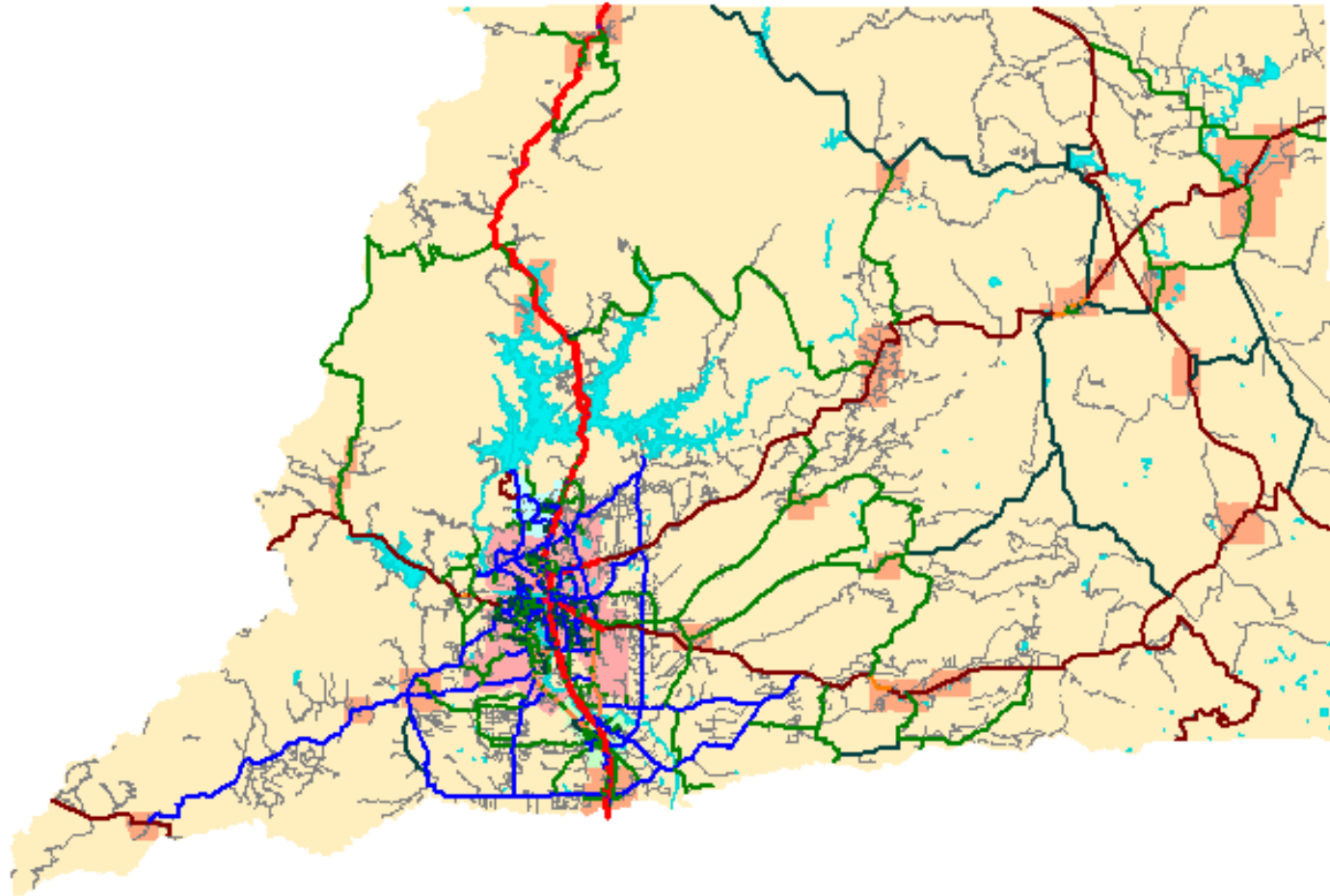
TAZs with Connectors



External Gateways



Model Outputs

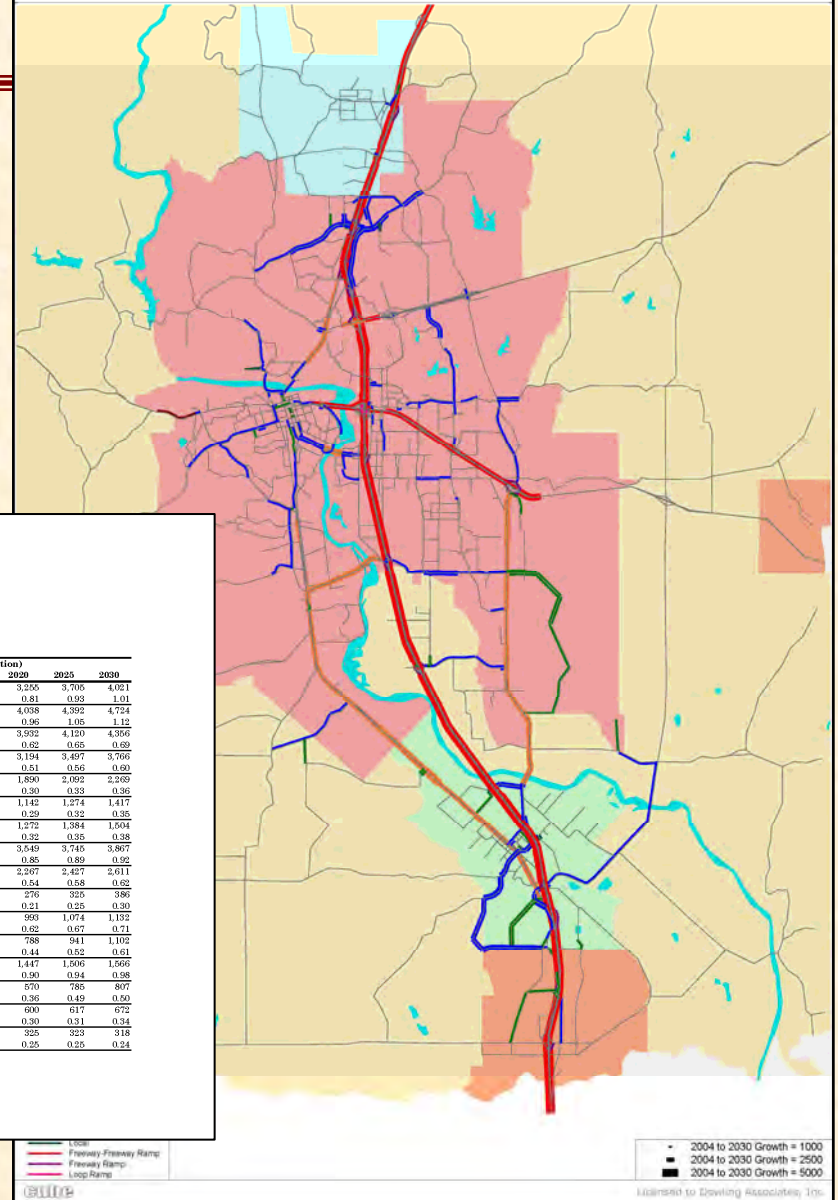


Traffic Volumes

SHASTA COUNTY TRAVEL MODEL
Travel Forecasts on Selected Road Segments

Road	Location	Volume V/C Ratio	Daily (Two-Way Total)					Growth 2004-2030	PM Peak Hour (Highest Direction)					
			2004	2010	2015	2020	2025		2030	2004	2010	2015	2020	2025
I-5	Tehama County Line	Volume V/C Ratio	41,500 0.69	51,959 0.62	58,973 0.71	67,928 0.81	76,217 0.93	84,177 1.03	2,358 0.50	2,485 0.52	2,855 0.65	3,255 0.75	3,705 0.92	4,021 1.01
I-5	N. of Riverside	Volume V/C Ratio	50,000 0.00	60,053 0.12	68,331 0.85	80,897 0.96	88,962 1.05	95,432 1.12	0 0.00	3,022 0.12	3,558 0.85	4,038 0.96	4,392 1.05	4,724 1.12
I-5	S. of SR 44	Volume V/C Ratio	67,000 0.50	77,136 0.55	87,006 0.59	99,907 0.62	99,988 0.65	102,742 0.69	3,120 0.50	3,459 0.55	3,705 0.59	3,932 0.62	4,120 0.65	4,356 0.69
I-5	N. of SR 273	Volume V/C Ratio	46,000 0.00	57,973 0.37	67,686 0.45	79,676 0.51	86,658 0.56	93,560 0.60	0 0.00	2,328 0.37	2,836 0.45	3,194 0.51	3,497 0.56	3,766 0.60
I-5	S. of SR 161 Shasta Dam	Volume V/C Ratio	34,000 0.00	37,707 0.22	42,517 0.25	48,561 0.30	53,409 0.33	58,255 0.36	0 0.00	1,363 0.22	1,611 0.25	1,890 0.30	2,092 0.33	2,269 0.36
I-5	Fairdale	Volume V/C Ratio	14,511 0.14	24,204 0.21	27,334 0.25	30,534 0.29	33,349 0.32	36,359 0.35	575 0.14	822 0.21	989 0.25	1,142 0.29	1,274 0.32	1,417 0.35
I-5	Siskiyou County Line	Volume V/C Ratio	18,800 0.00	22,228 0.25	24,931 0.29	27,723 0.32	30,241 0.35	32,969 0.38	0 0.00	1,010 0.25	1,141 0.29	1,272 0.32	1,384 0.35	1,504 0.38
SR 44	W. of I-5	Volume V/C Ratio	52,000 0.75	52,947 0.70	59,012 0.80	62,340 0.85	64,666 0.89	67,569 0.92	3,197 0.75	2,922 0.70	3,571 0.80	3,545 0.85	3,745 0.89	3,867 0.92
SR 44	E. of Victor	Volume V/C Ratio	37,086 0.45	37,129 0.50	38,517 0.52	41,019 0.54	43,059 0.58	46,520 0.62	1,888 0.45	2,118 0.50	2,170 0.52	2,267 0.54	2,427 0.58	2,611 0.62
SR 44	E. of Wilson Hill	Volume V/C Ratio	4,123 0.15	4,668 0.16	5,097 0.18	5,717 0.21	6,470 0.25	7,386 0.30	103 0.15	209 0.16	237 0.18	276 0.21	325 0.25	386 0.30
SR 161	E. of Cascade	Volume V/C Ratio	15,100 0.44	15,370 0.62	16,827 0.65	19,611 0.69	21,789 0.71	23,882 0.71	705 0.44	834 0.62	881 0.65	993 0.69	1,074 0.71	1,132 0.71
SR 273	N. of Deschutes	Volume V/C Ratio	9,100 0.24	12,045 0.29	12,470 0.31	12,732 0.44	15,376 0.52	20,750 0.61	434 0.24	529 0.29	562 0.31	788 0.44	941 0.52	1,102 0.61
SR 273	S. of Quartz Hill	Volume V/C Ratio	20,500 0.73	22,884 0.83	24,813 0.88	26,989 0.90	29,192 0.94	30,833 0.98	1,105 0.73	1,351 0.83	1,406 0.88	1,447 0.90	1,596 0.94	1,666 0.98
SR 299	W. of Ridge	Volume V/C Ratio	10,963 0.32	11,372 0.34	11,791 0.35	12,289 0.36	15,588 0.49	16,058 0.50	512 0.32	540 0.34	552 0.35	570 0.36	785 0.49	807 0.50
SR 299	E. of Old Oregon	Volume V/C Ratio	10,000 0.30	9,723 0.28	9,863 0.29	10,200 0.30	10,694 0.31	10,972 0.34	592 0.30	564 0.28	570 0.29	600 0.30	617 0.31	672 0.34
SR 299	E. of Black Ranch	Volume V/C Ratio	6,500 0.00	6,831 0.22	7,197 0.24	7,508 0.25	7,657 0.25	7,801 0.24	0 0.00	285 0.22	310 0.24	325 0.25	323 0.25	318 0.24

SHASTA COUNTY MODEL
PM Peak Hour Traffic Growth from 2004 to 2030
Line Width Scaled to Difference in Model Traffic Volume



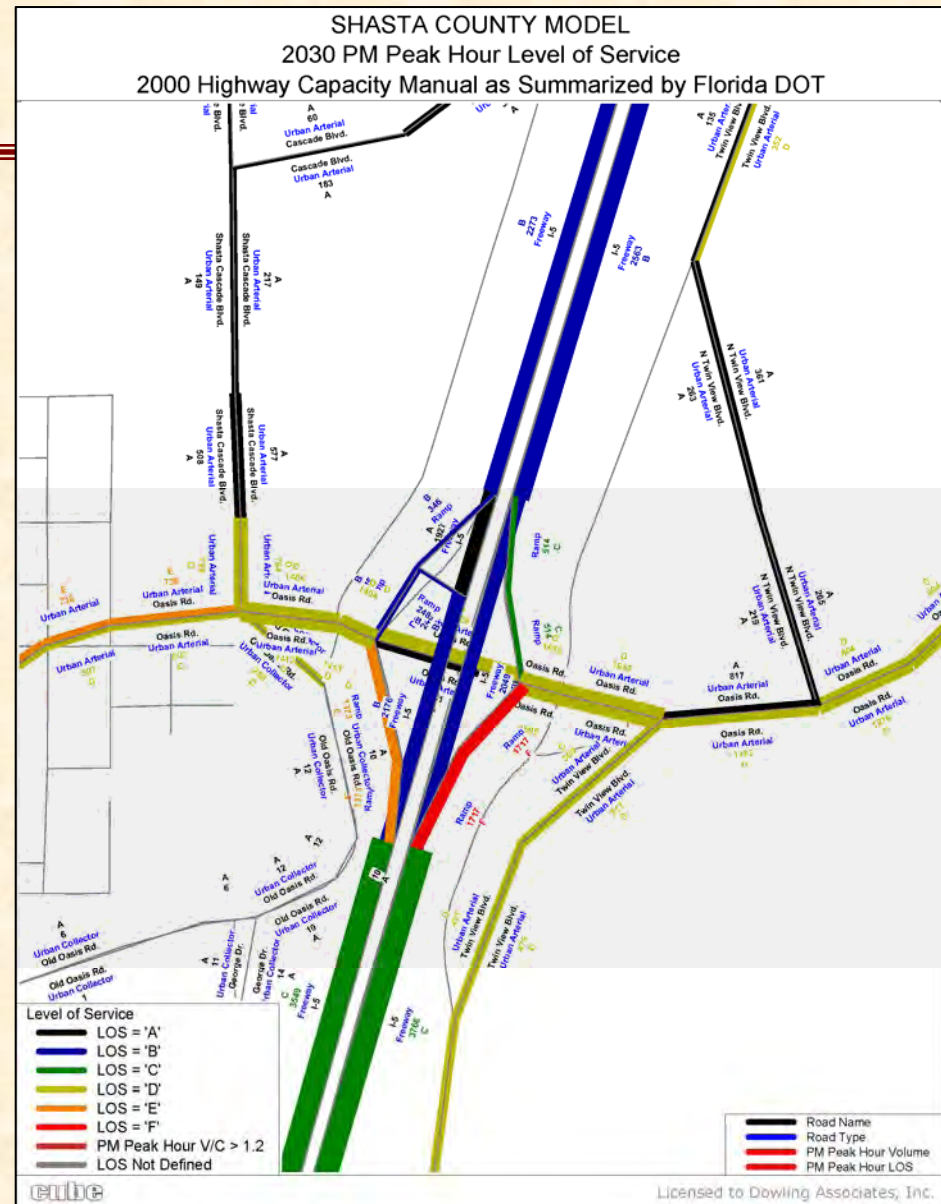
Regional Performance Measures

	Vehicle Miles of Travel (VMT)	Vehicle Hours of Travel (VHT)	Vehicle Hours of Delay (VHD)	Average Speed (miles per hour)		
Year	Daily	Daily	Daily	A.M. Peak Period	P.M. Peak Period	Off-Peak
2004	5,315,000	127,600	4,000	39.3	38.7	42.3
2005	5,395,000	129,700	4,400	39.3	37.8	42.3
2010	5,995,000	140,900	3,700	40.0	39.8	42.7
2015	6,487,000	153,700	4,700	39.6	39.5	42.8
2020	7,084,000	168,800	6,700	39.0	38.5	42.7
2025	7,655,000	183,700	8,900	38.7	38.4	42.4
2030	8,235,000	201,300	13,500	37.9	37.0	41.8

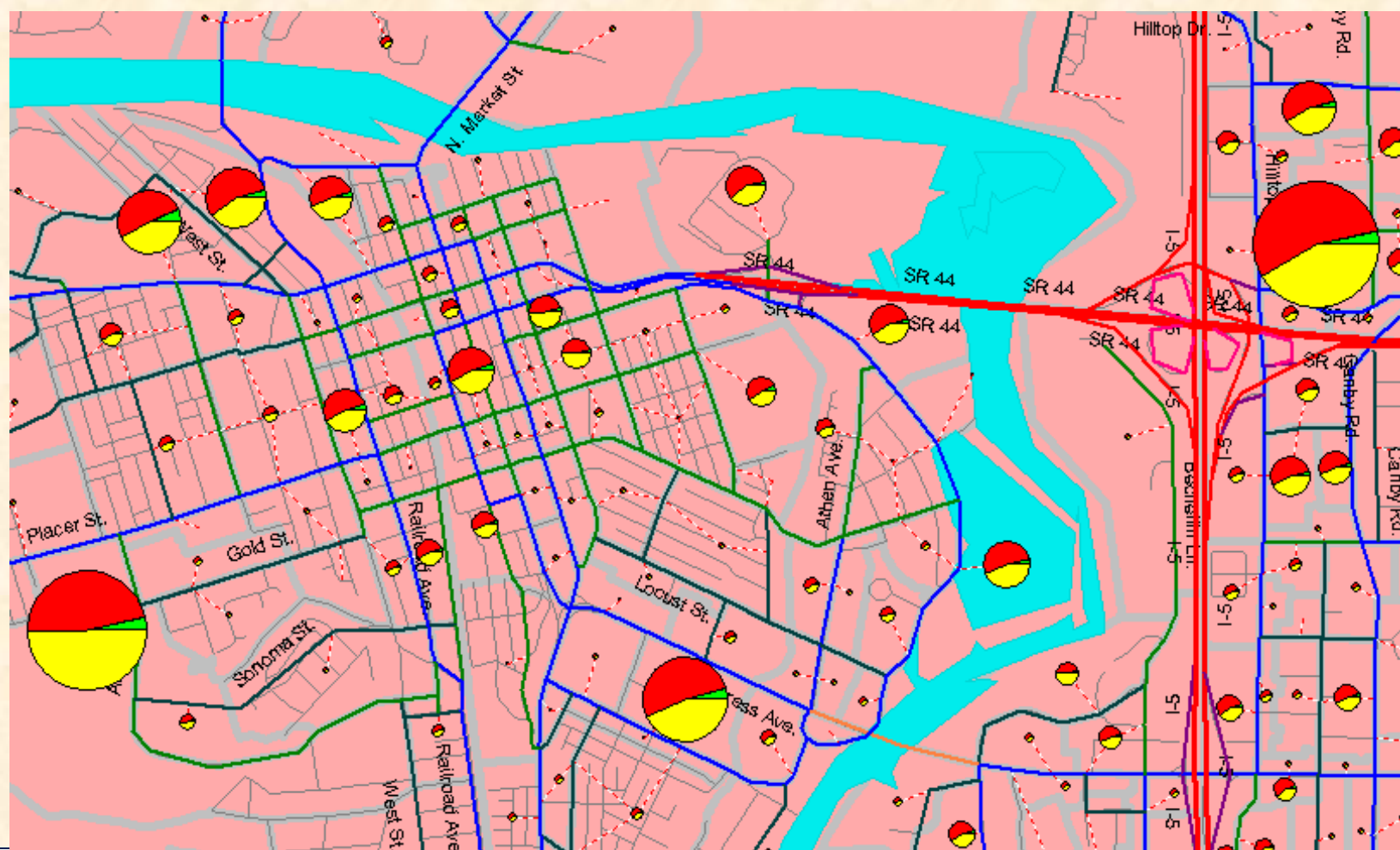


Level of Service

- Based on average segment capacities
- Not intersection analysis

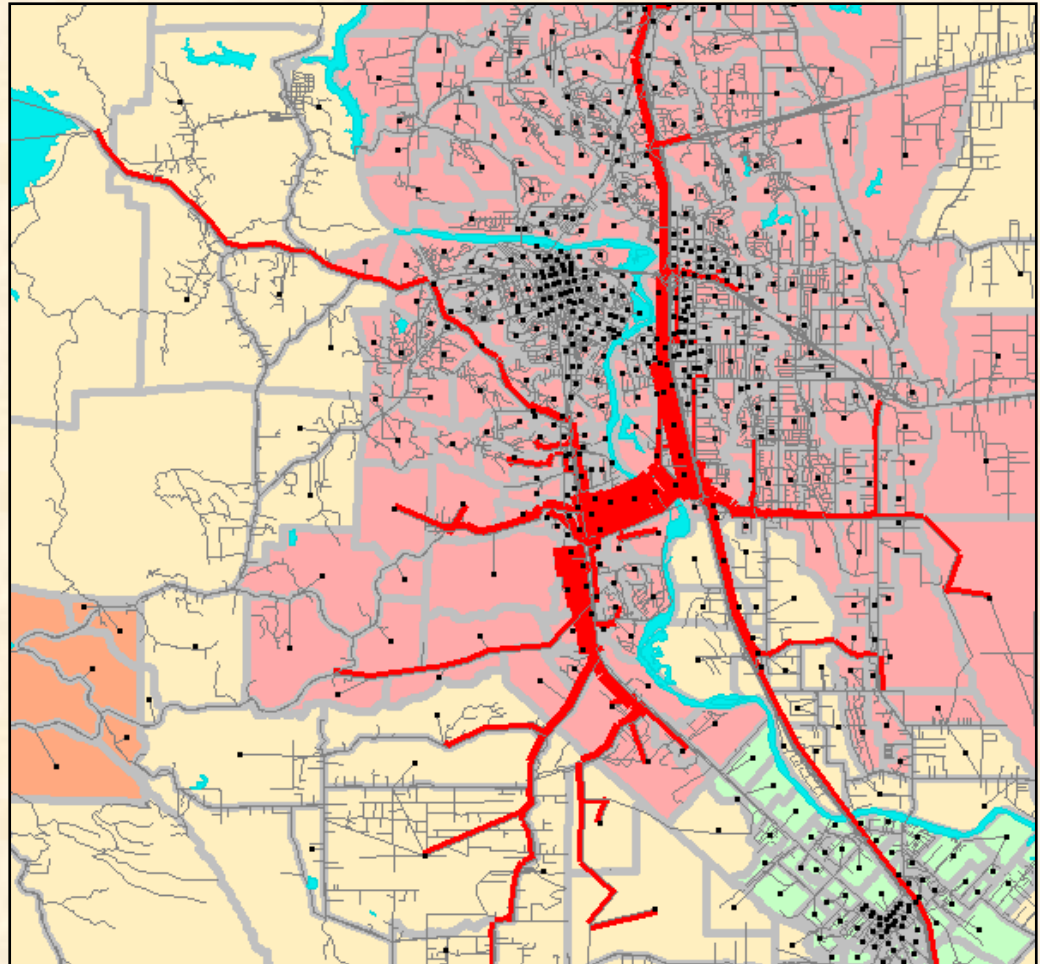


TAZ Data – Example: Mode Shares



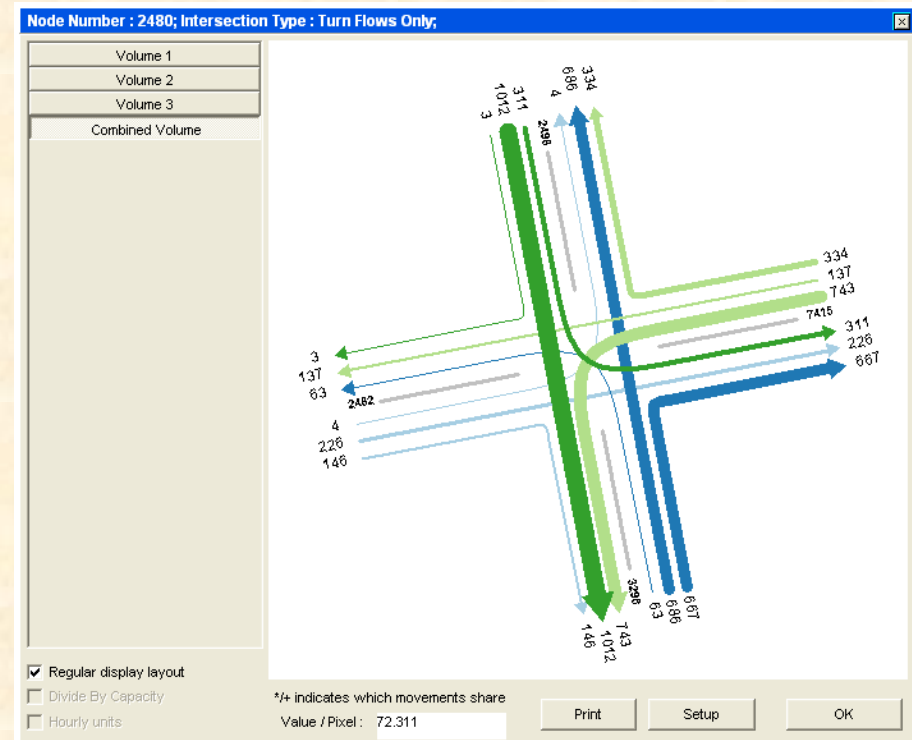
Select Link Trips

- Trace origins and destinations for trips on South Bonnyview



Intersection Turns

- Generally do not use directly from model
- Main problem is aggregation to TAZs

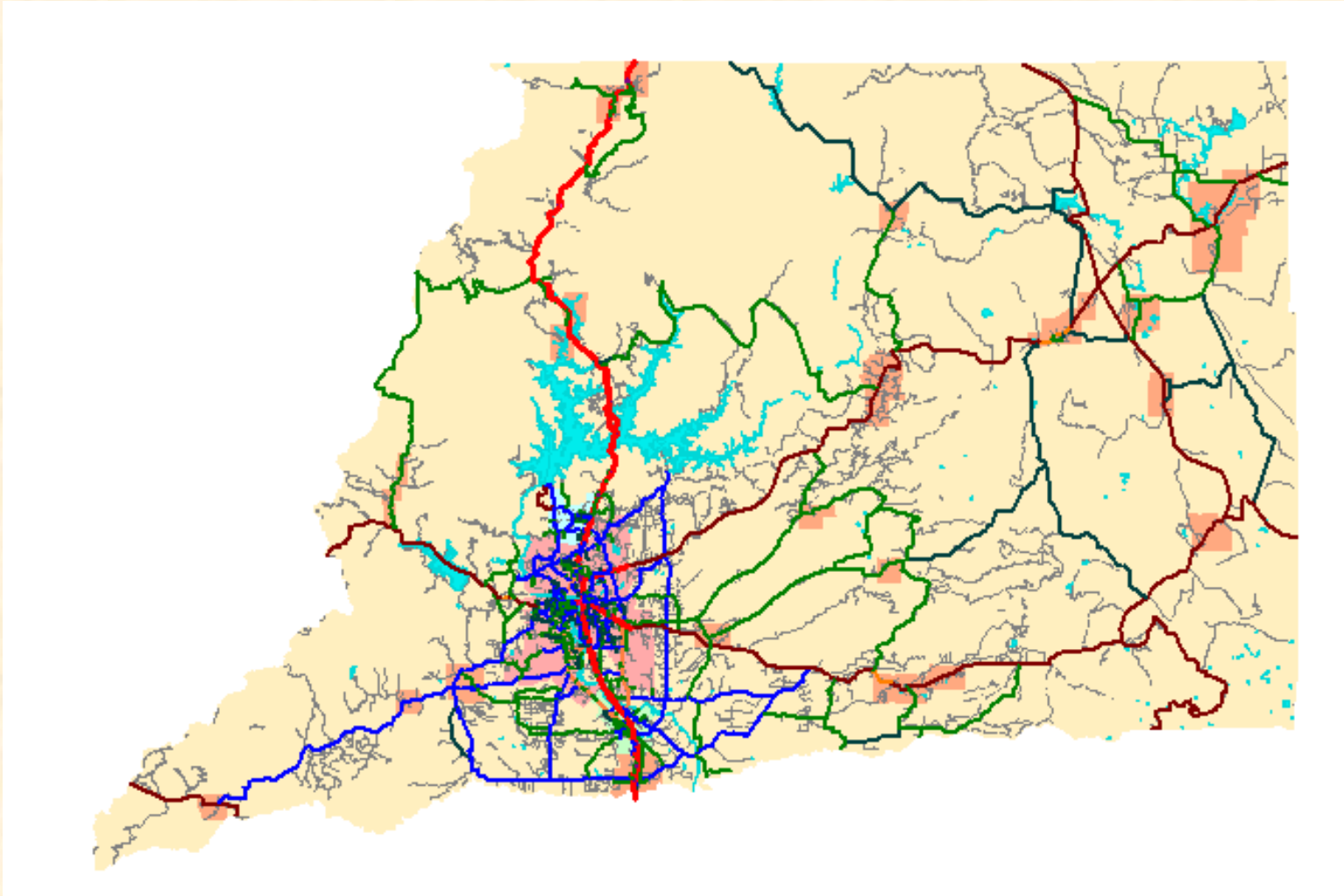


Adjustment Processes

- Built-in ODME (Origin Destination Matrix Estimation)
 - Adjustments applied to 2004 base year only
 - Base year (2004) trip origins and destinations were adjusted to better match traffic counts
- Forecasts use increments from UNADJUSTED 2004 to UNADJUSTED forecast year
 - Added to ODME adjusted 2004 trips
 - Maintains model sensitivity to land use and networks



Additional Slides



Trip Generation

- Divide into trip purposes:
 - Why? Different lengths in trip distribution
 - Example: Home-Work, Home-Shop, Non-Home
- Rates often based on household diaries
 - Probably okay for daily commute trips
 - People may leave out many short trips



P's and A's – Yikes!

- Every trip at the home end (Production) should match up with a trip at the non-home end (Attraction)
- Every model handles imbalances differently
 - Many keep P's constant, factor A's to match
 - Can make jobs disappear by factoring down A's
 - Dowling alternative – don't factor within study area, make up difference from outside study area



Comparison with ITE

- Regional travel rates are often much lower, particularly for retail
- ITE Trip Generation uses vehicles, not persons
- **OPINION:** ITE driveway counts pick up many short trips which are not recorded well in surveys or left out of regional models
- Amazingly, the number of trips assigned to major streets can be identical using either set of rates



Trip Distribution

- “Gravity Model” is most common
 - Trips proportional to trip ends in TAZs
 - Inversely proportional to travel time
- Friction Factors
 - Old-style lookup tables
 - Newer models generally use formulas
- K-Factors
 - Adjustments for specific pairs of TAZs
 - Supposed to represent factors other than travel time – bridges, language barriers, etc...
 - Commonly abused, but far from the worst thing we can do



Gravity Model Formula

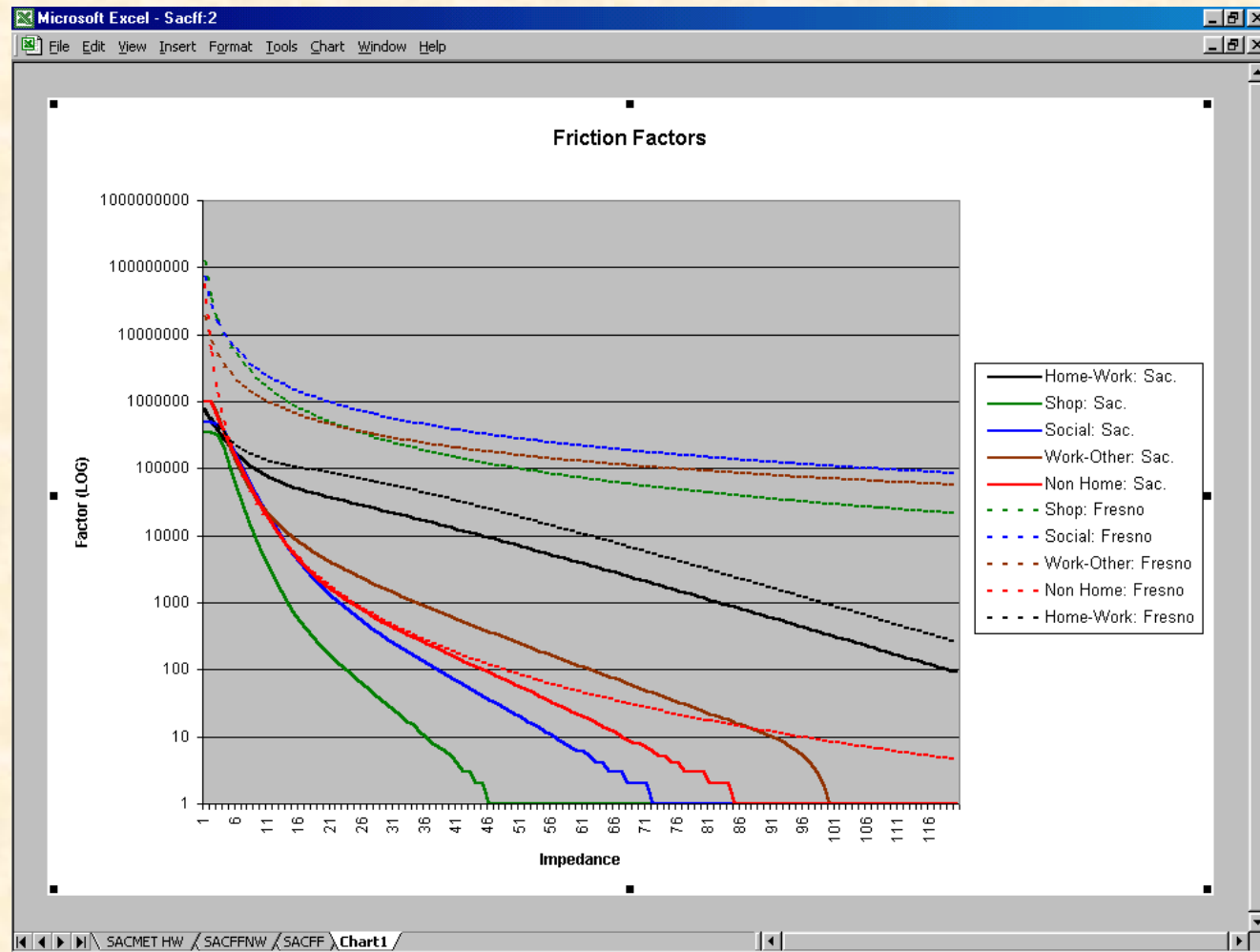
- Proportion of Zone A productions going to Zone B attractions =

$$\frac{\text{Zone B Attractions} * (\text{Friction Factor for A to B})}{\text{Sum of all } [\text{Zone x Attractions} * \text{Friction Factor for A to x}]}$$

- Iterate until Attraction ends add up to correct totals



Distribution Factors



Mode Choice

- “Mode Split” implies trips can be split based on travel times, costs
- “Mode Choice” implies that characteristics of traveler are important
- Significantly increases model complexity
- Need to consider personal characteristics – income, etc...



Logit Model Formula

$$P(a) = \frac{\exp(U_a)}{\sum_j \exp(U_j)}$$

where:

$P(a)$ = Probability of choosing mode "a".

$\exp$ = The exponential function "e" (2.71).

U_a = The utility of mode "a".



Trip Assignment

- Network attributes
 - “Free-flow” (11 P.M.) speeds
 - Capacities
 - LOS E or C? Older models use C
 - Volume-delay functions
 - Relate speed to V/C
 - Older models based on LOS C capacities!
 - What happens when V/C s are >1.2 or so?
- Iterative process
 - Equilibrium – no drivers can switch routes and find a faster route
 - How many iterations to remove “lumps”?



Validation Tools



- Check specific land uses
- Adjust assumed “free-flow” speeds within reasonable limits
- Adjust zone connectors
- Adopt adjustment process so that model is used for growth increments rather than absolute volumes



Validation Tools (2)

- ODME (Origin-Destination Matrix Estimation)
- Factor initial trip table from standard process to match counts on links
- Makes validation look better
- How do you apply it to the future?
 - Factors? Increments?

